



Microwave Enhancement of Reaction Kinetics in Serpentine Dehydroxylation Reactions

M.R. Silsbee, B.J. Kearns and W.B. White
The Materials Research Institute
The Pennsylvania State University
University Park, PA

Second Annual Conference on Carbon Sequestration
Hilton Alexandria Mark Center
Alexandria, VA.
May 5-8, 2003



MRI



Motivation

Sequestration of CO_2 as MgCO_3 Using Mg-Minerals as Feedstock

- 1) How to Improve kinetics?
- 2) How to minimize energy input?
- 3) How to avoid or minimize reagents?

Objectives

Long Term

Can microwave processing catalyze sequestration reactions such as :

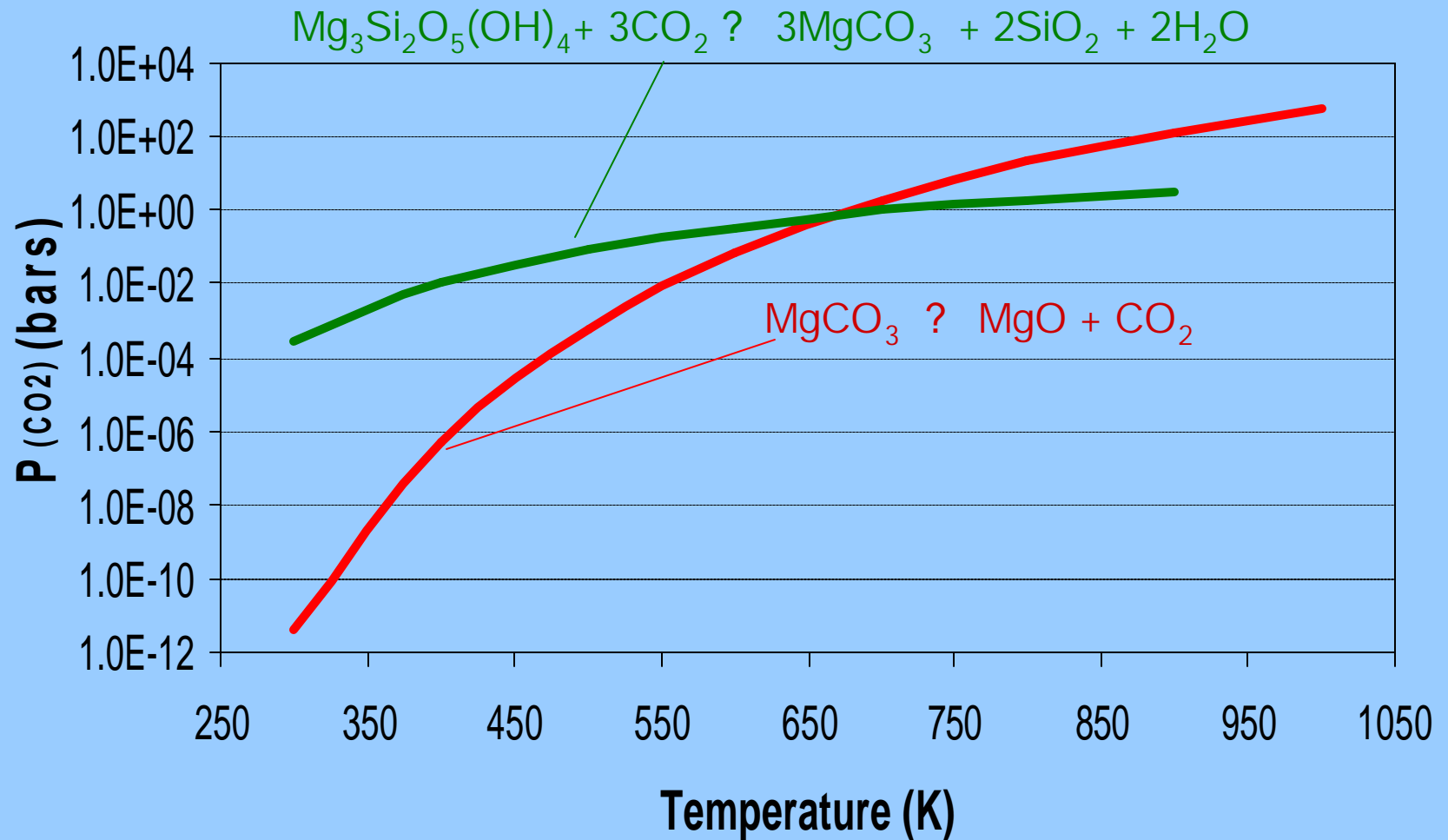


Short Term (This paper)

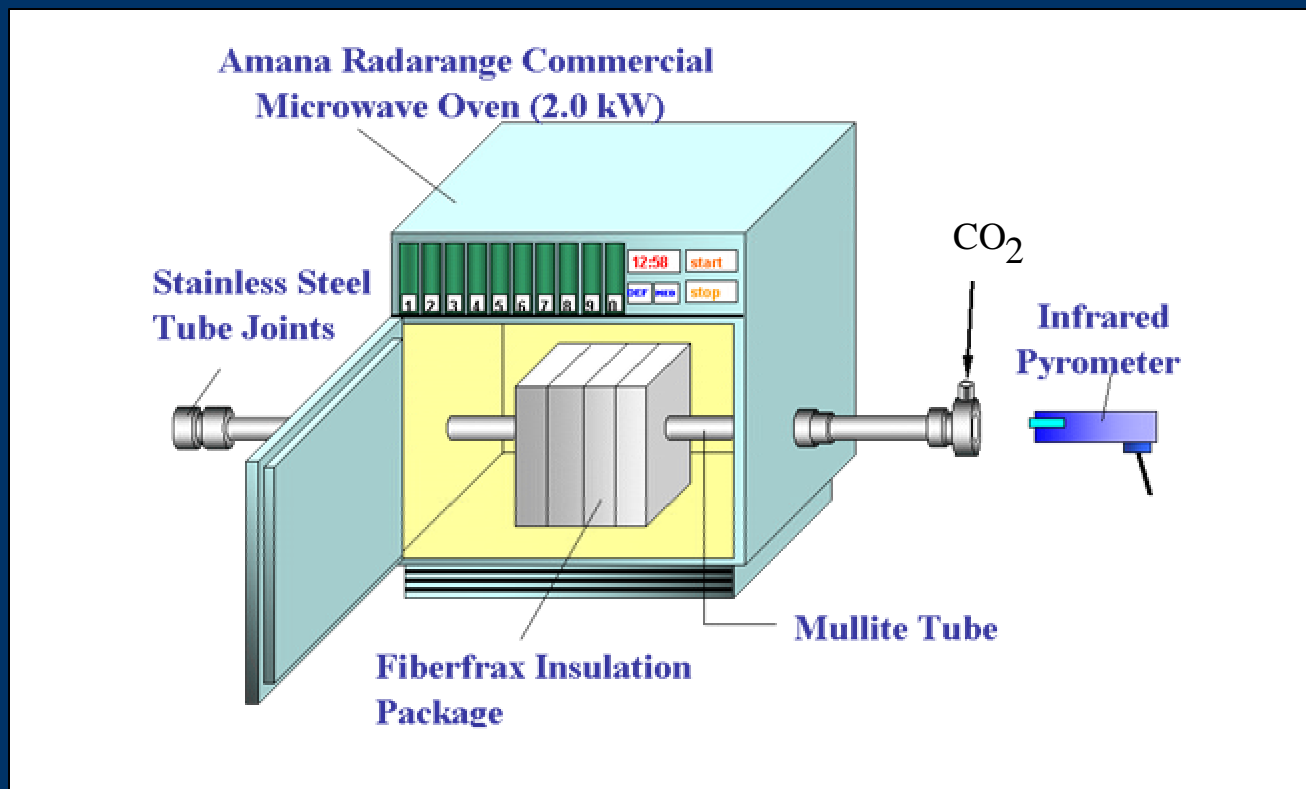
Demonstrate efficacy of microwave enhancement of reaction rates by comparing kinetics – microwave vs. thermal- the dehydration reaction:



Equilibrium Calculations



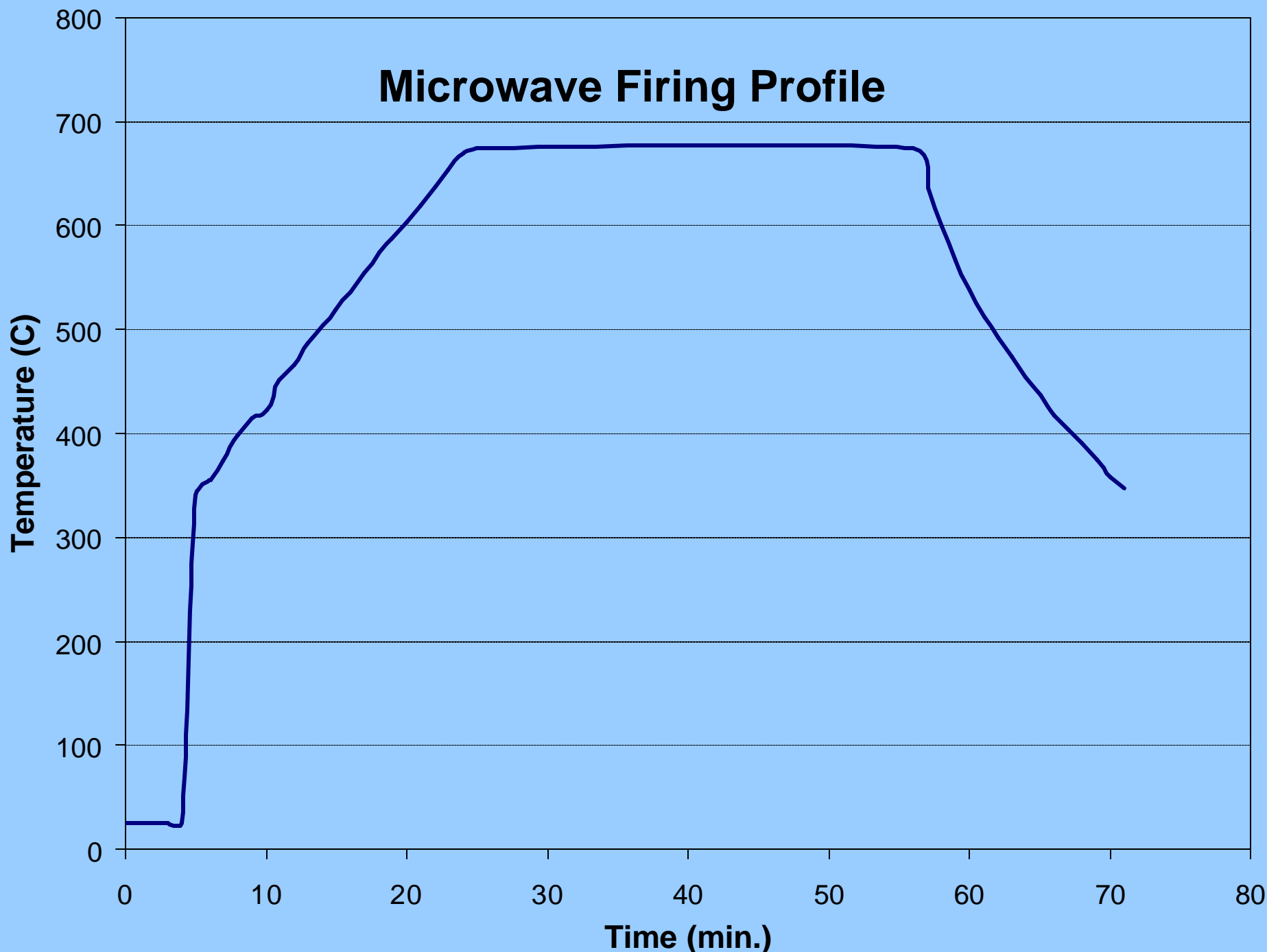
Scheme of the Tube Microwave Processing Setup



MICROWAVE PROCESSING SYSTEMS AT MPEC, MRI

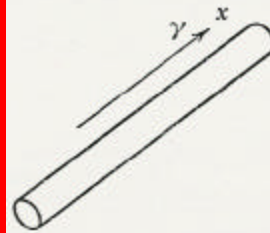


2.45 GHz, 2 kW Tube Microwave Processing Setup

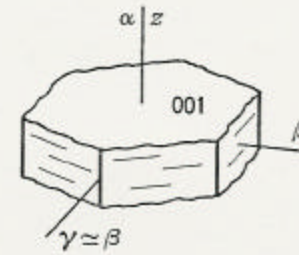


Structure of Serpentine Materials

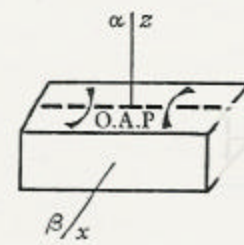
MONOCLINIC (—)



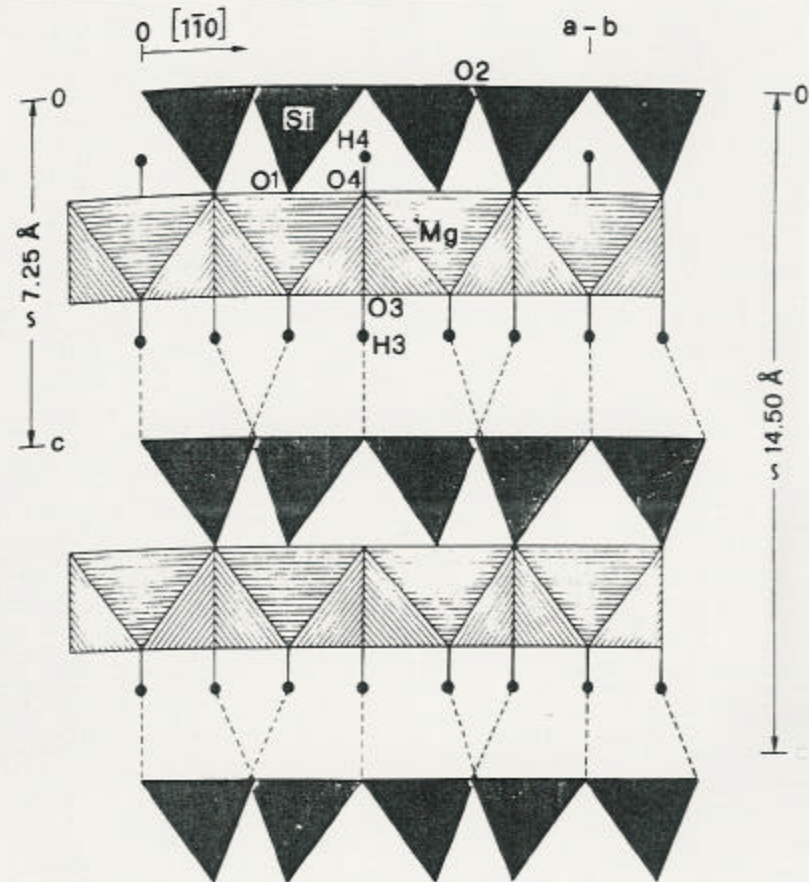
Chrysotile

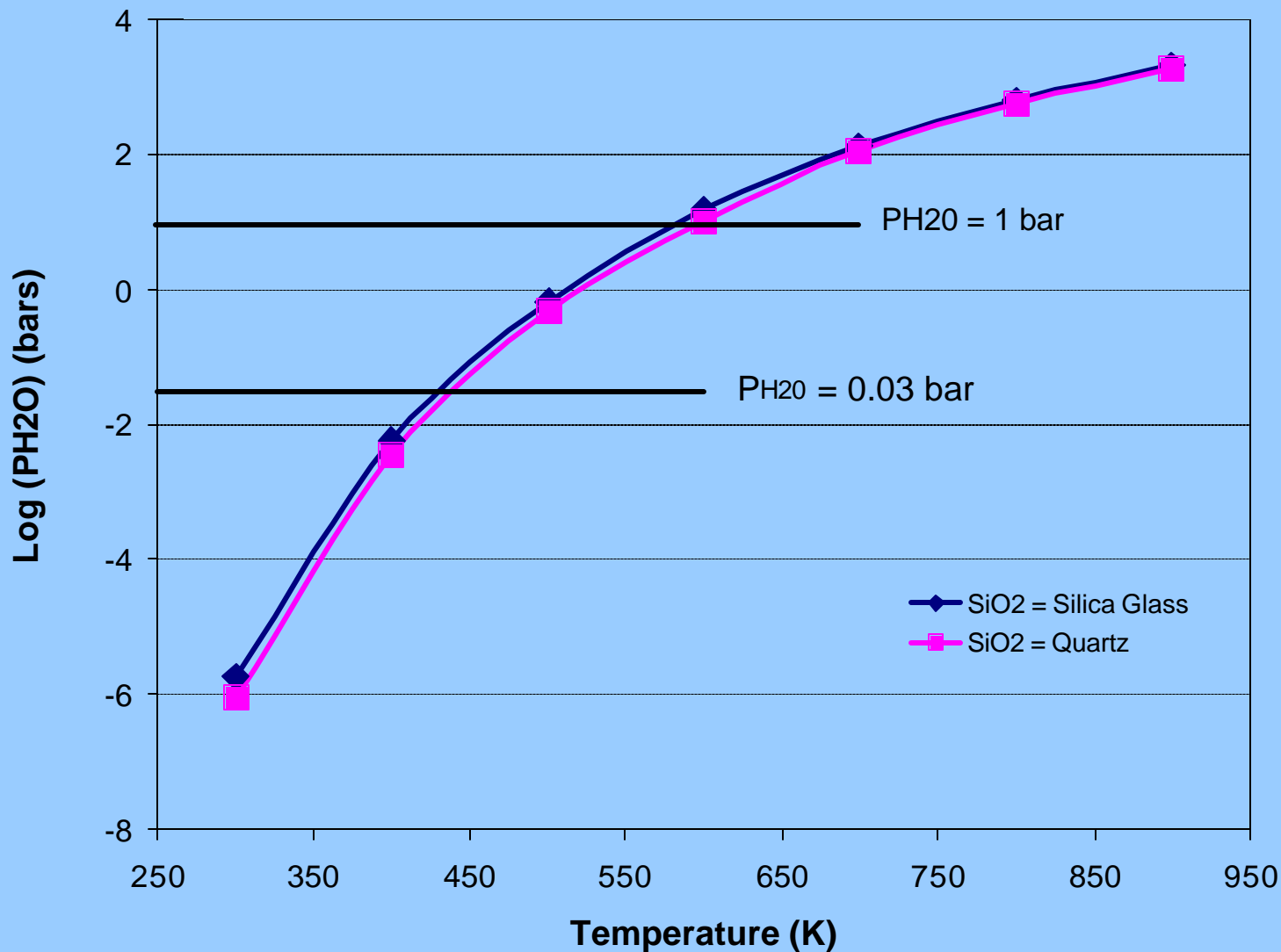


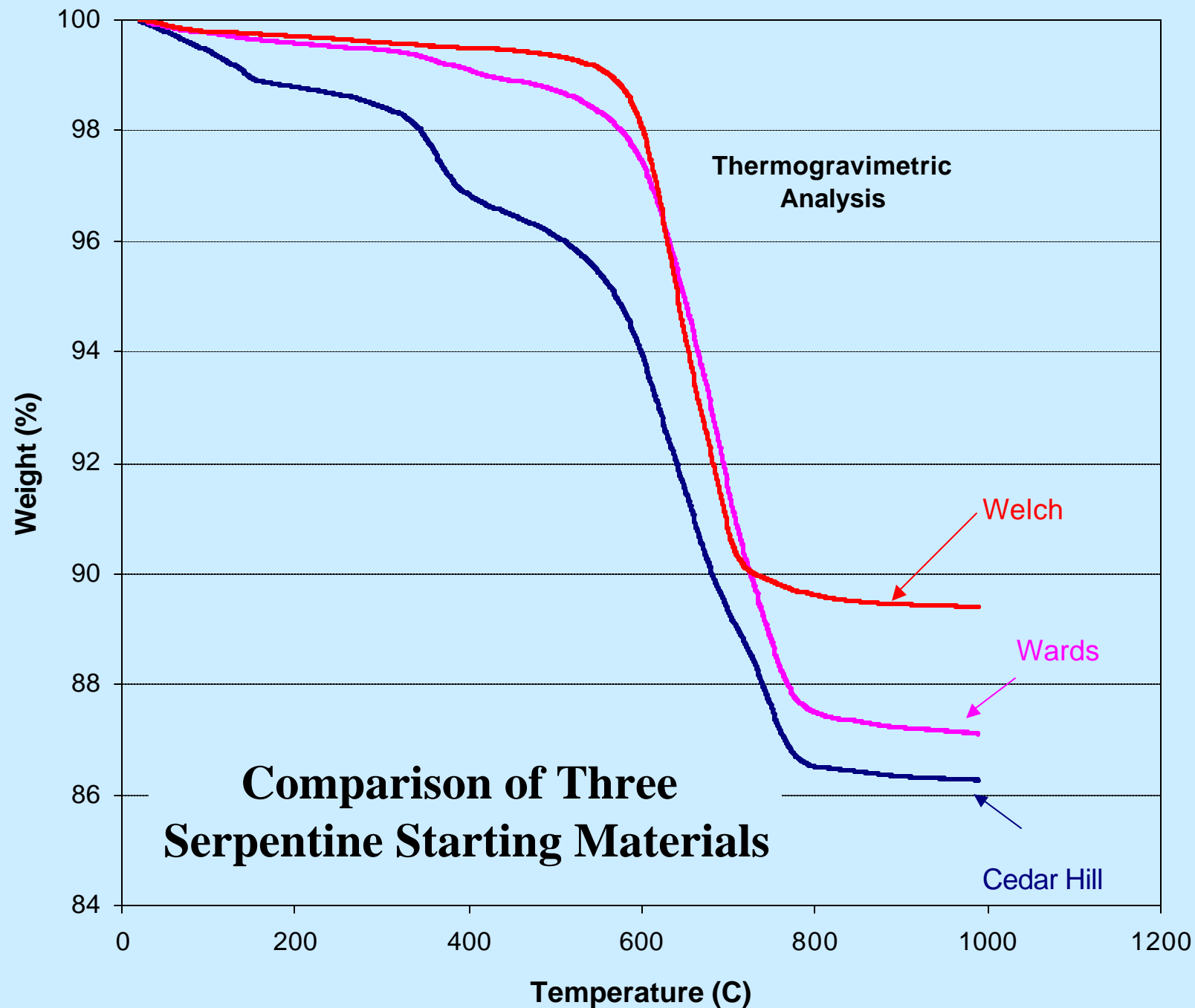
Lizardite



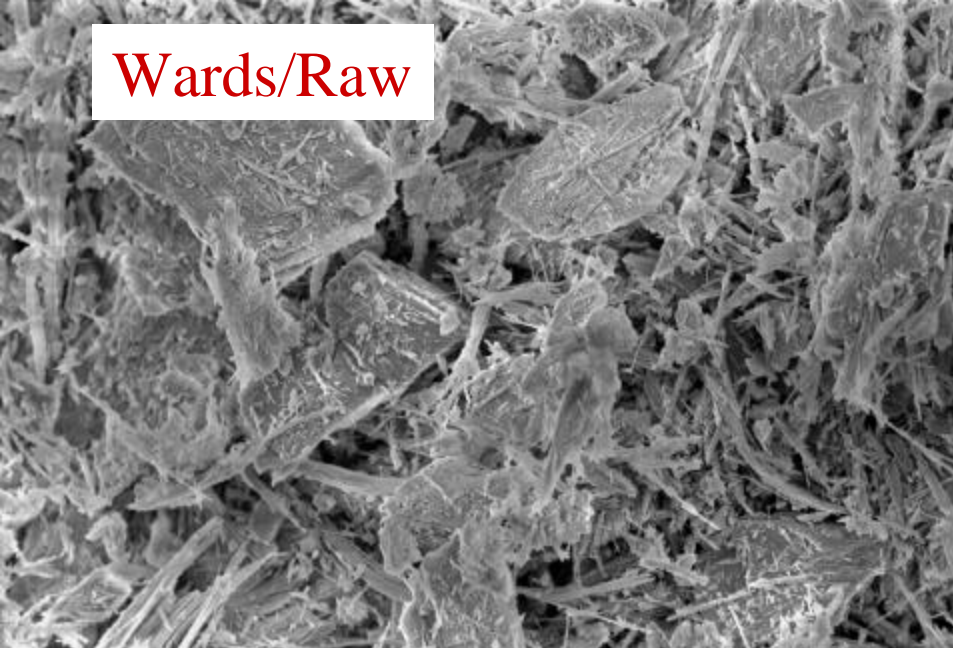
Antigorite





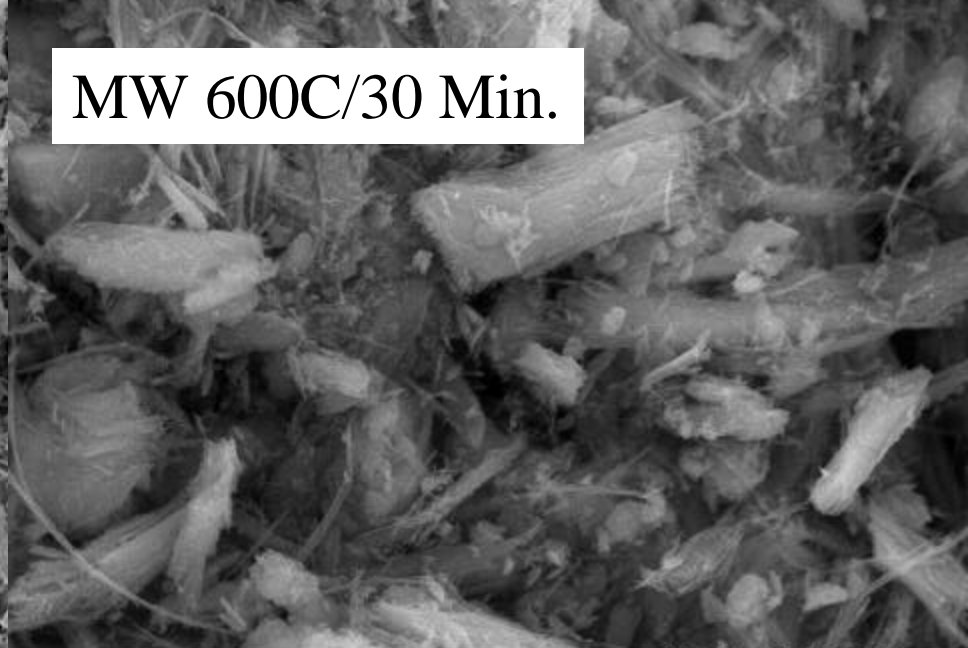


Wards/Raw



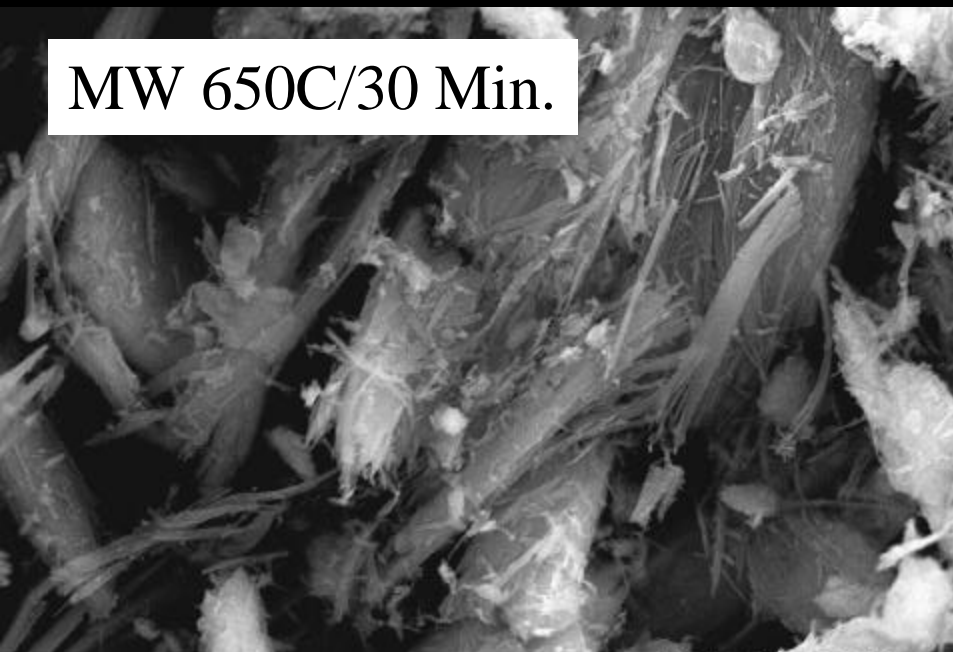
SE 01-Apr-03 Ward WD 6.9mm 5.00kV x3.0k 10um

MW 600C/30 Min.



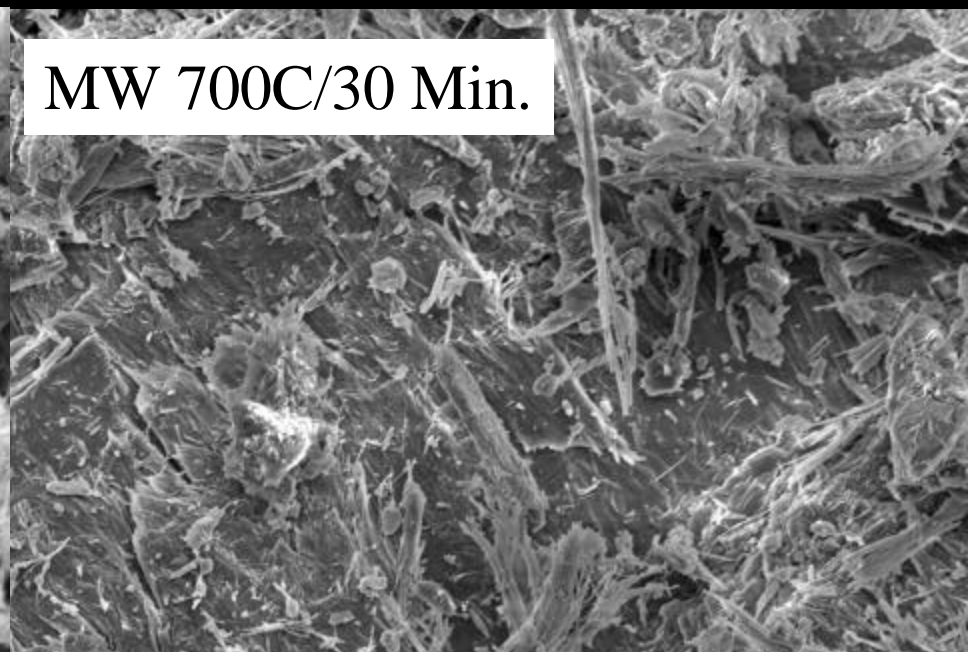
SE 24-Mar-03 WARDS WD 7.3mm 25.0kV x3.0k 10um

MW 650C/30 Min.



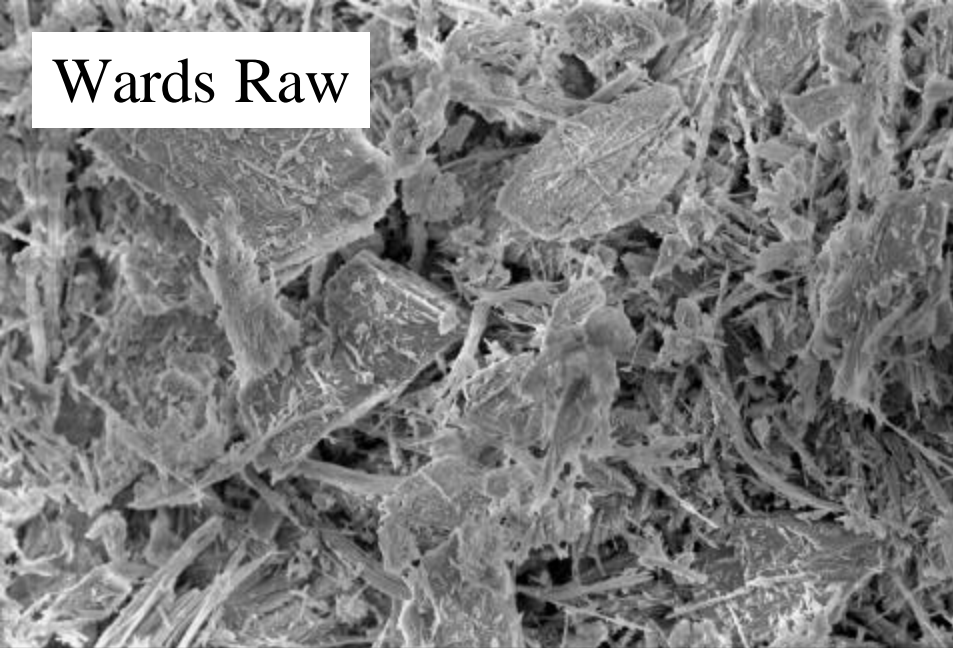
SE 24-Mar-03 WARDS WD 7.1mm 25.0kV x3.0k 10um

MW 700C/30 Min.



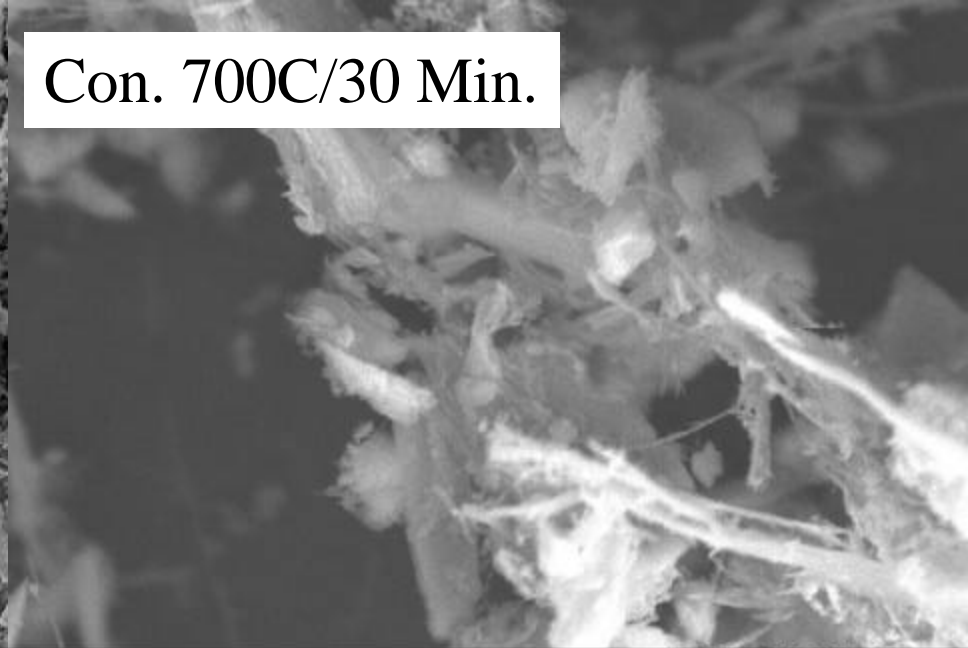
SE 01-Apr-03 Ward WD 7.6mm 5.00kV x3.0k 10um

Wards Raw



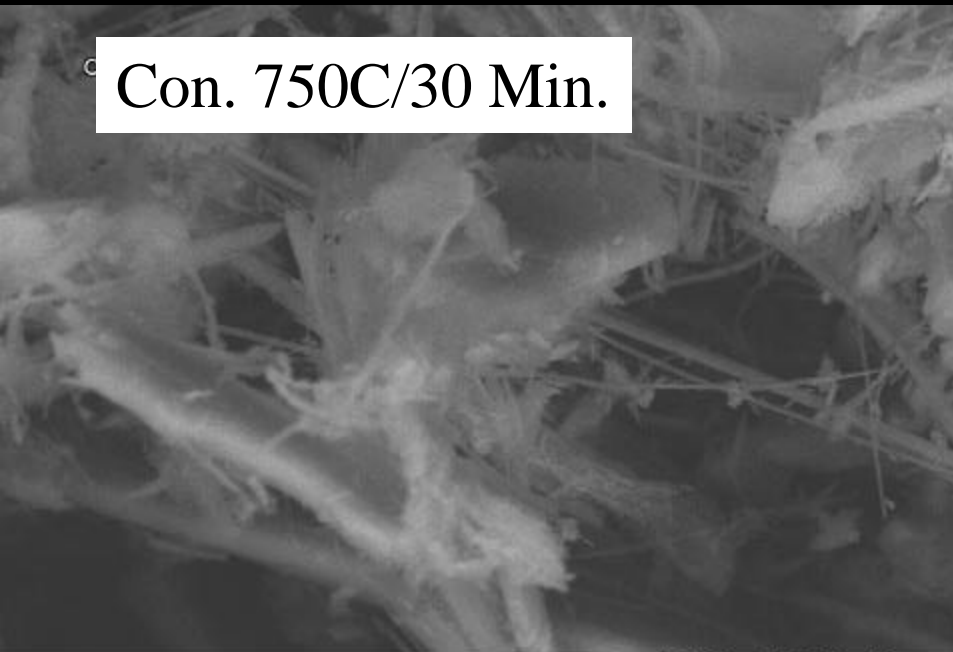
SE 01-Apr-03 Ward WD 6.9mm 5.00kV x3.0k 10um

Con. 700C/30 Min.



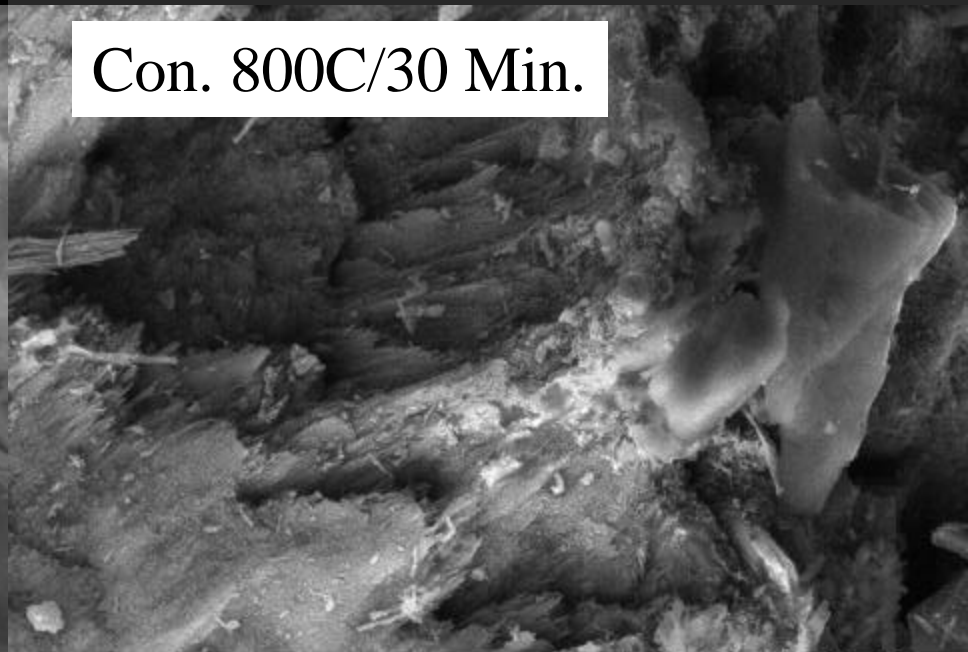
BSE1 04-Apr-03 WARDS WD 9.0mm 20.0kV x3.0k 10um

Con. 750C/30 Min.

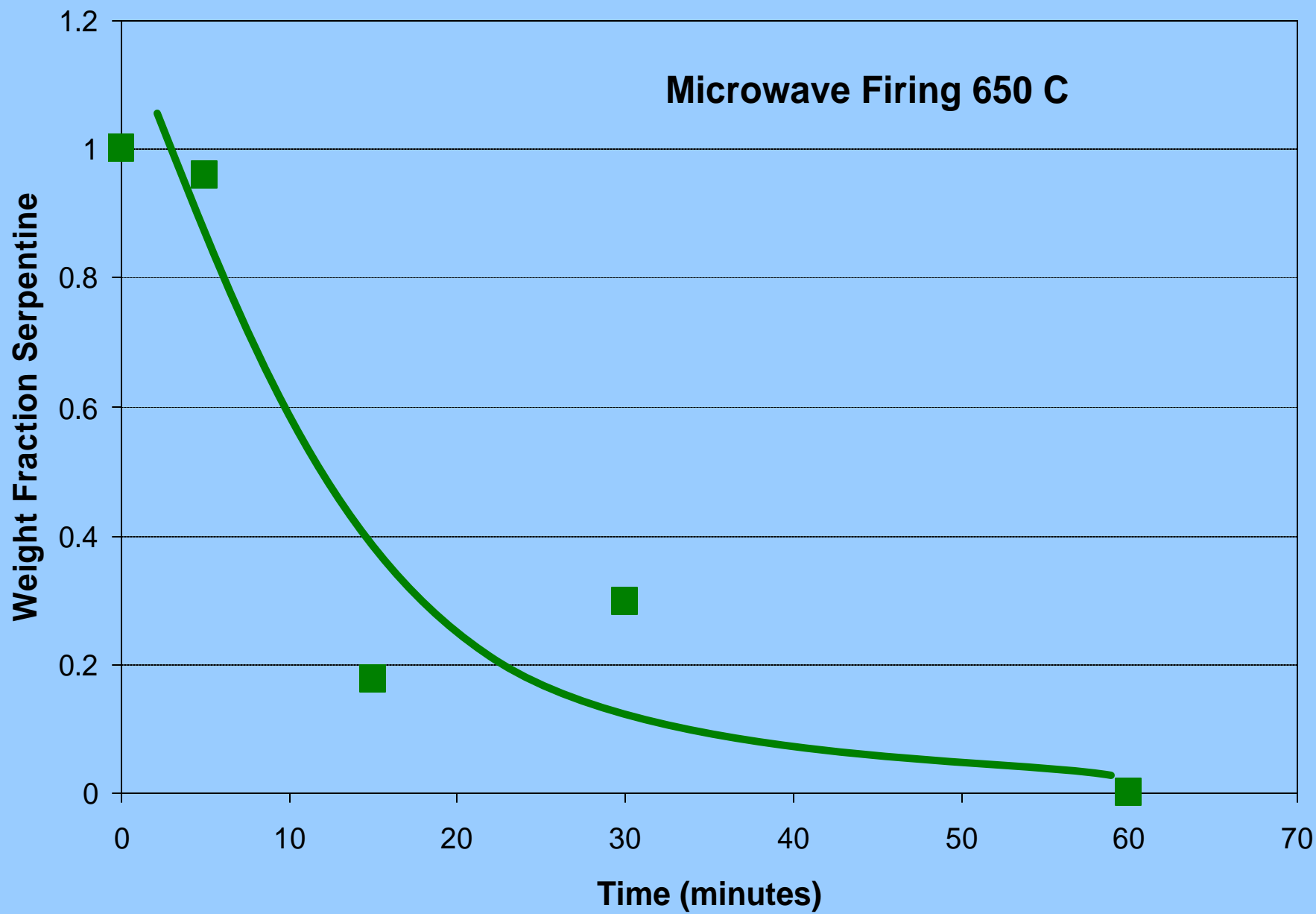


BSE1 07-Apr-03 wards WD10.4mm 20.0kV x3.0k 10um

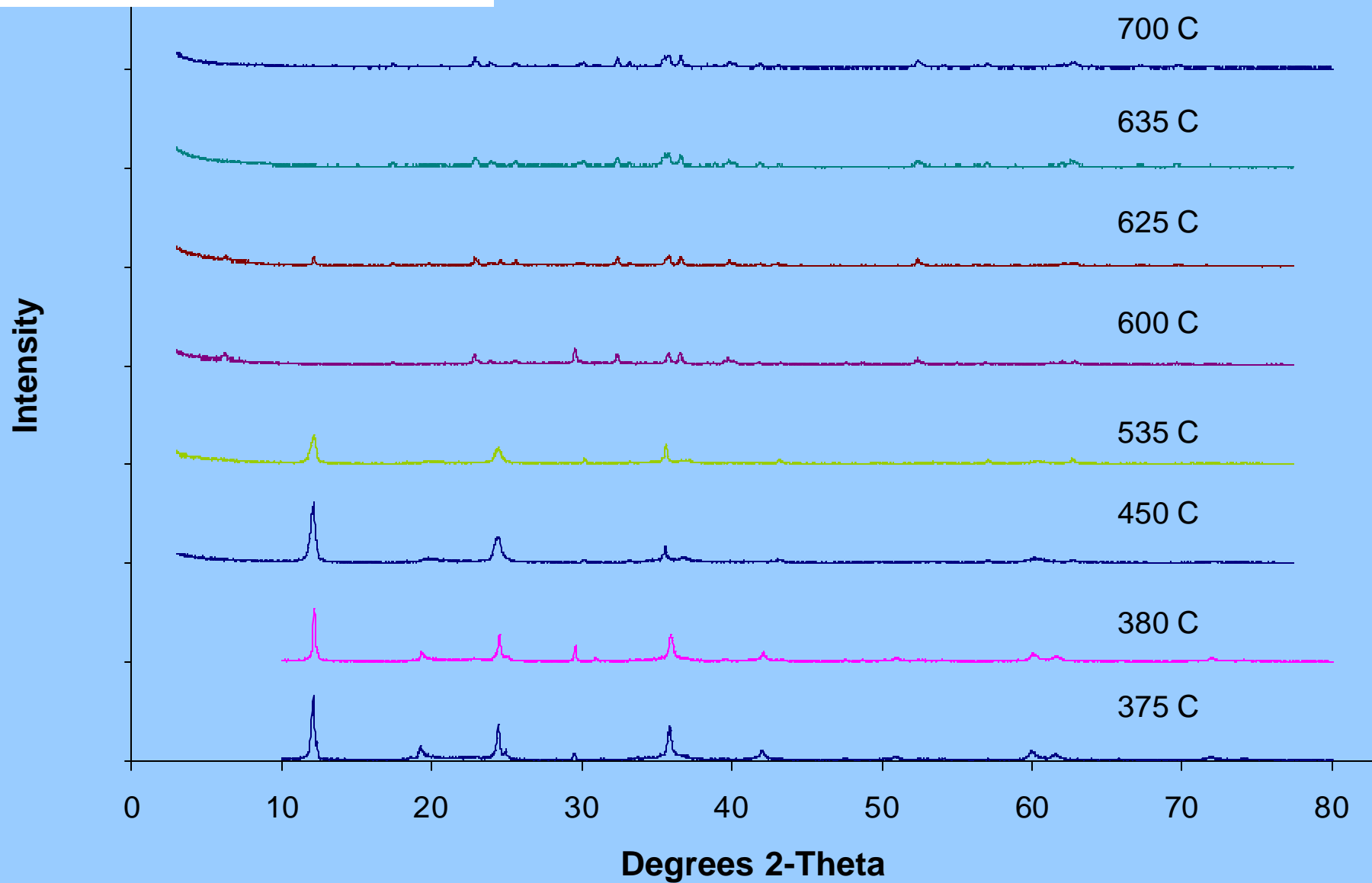
Con. 800C/30 Min.



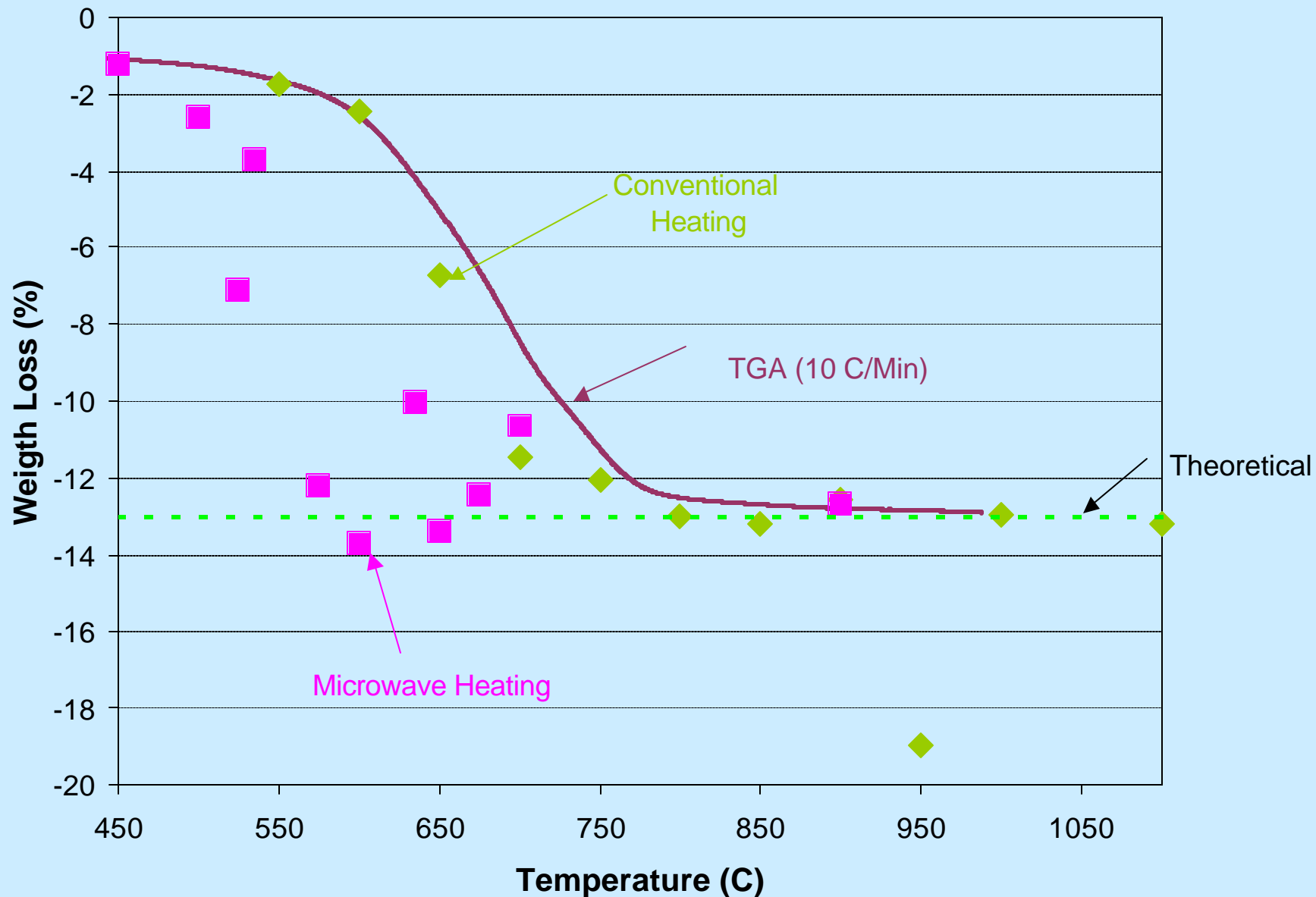
BSE1 07-Apr-03 wards WD10.1mm 20.0kV x3.0k 10um

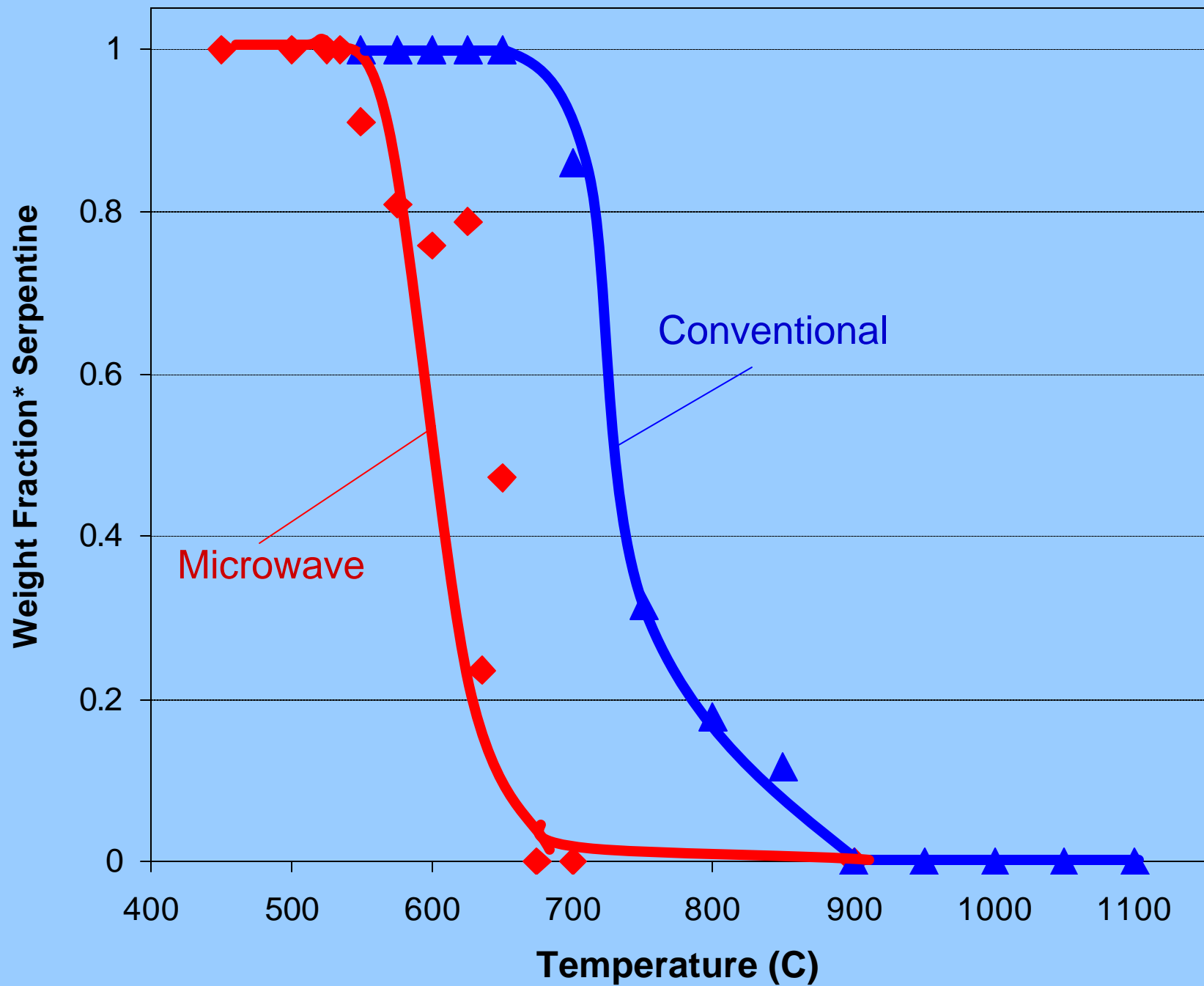


X-ray Diffraction Patterns of Microwave Products



Comparison: Microwave Firing, Conventional Firing and TGA





* BASED ON PERCENT CRYSTALLINE PHASE

Conclusions

1) For dehydroxylation reaction:



microwave processing lowers threshold by $\sim 100^\circ\text{C}$.

2) Products contain unknown amorphous phase(s).

3) Question: Does microwave dehydroxylation prepare surfaces for carbonation reactions